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ABSTRACT

This document is concerned with determining student attitudes towards the support of scientific research. It is divided into three major topics. The first section briefly summarizes recent concern in the scientific community over public attitudes toward science. Section two reviews public opinion data on attitudes towards science, and three presents some findings from the 1976-77 science assessment on support for scientific research among the nation's youth. Recent survey information indicates that while public opinion of scientists has dropped since the middle 1960s, it is still better in comparison to other professionals. Results of the support for research assessment among the nation's 17-year-olds suggest that a person's knowledge of science may play an important part in determining the extent of that support. It is suggested that attempts to heighten young citizens' interest in and knowledge of science are in the best interests of the scientific community. (Author/MA)

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SCIENTIFIC LITERACY

AND

SUPPORT OF SCIENTIFIC RESEARCH

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SCIENTIFIC LITERACY AND SUPPORT OF SCIENTIFIC RESEARCH

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National Assessment of Educational Progress
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DATA EXPLORATION AS RESEARCH: THE NATIONAL ASSESSMENT

Chairman: Francis V. Corrigan
National Center for Education Statistics

Introduction

This paper presents a descriptive analysis of one small portion of data collected during the 1976-1977 science assessment conducted by the National Assessment of Educational Progress (NAEP). The data reported in this paper relate attitudes towards support of various scientific research areas, such as energy, pollution and food production, to cognitive performance in many of these same areas. The cognitive-attitudinal relationships are examined in greater detail by introducing several demographic and self-report questionnaire variables.

The theme paper of this symposium (Burton, 1978) maintains that large-scale survey data may help educational researchers generate and explore hypotheses. The 1976-1977 science objectives reflect the diversity of philosophies of the goals of science education today. The data obtained on this broad set of objectives are intended to be useful to science educators and other researchers, including those engaged in the exploration of diverse hypotheses leading to the formation of paradigms. For this reason, the entire domain of the science assessment will be briefly described before commencing the main topic of this paper.

1976-1977 NAEP Science Categories[1]

The objectives and instruments of the 1976-1977 science assessment differ in four main respects from those of the previous two science assessments (Harms, 1977). First, new categories have been developed to

[1] A comprehensive description of the objectives and development process is given in Science Objectives for the 1976-1977 Assessment (forthcoming) from National Assessment. The report includes a summary of objectives from the first two science assessments.

assess knowledge and attitudes concerning the interface of science, technology and persistent societal problems such as population, environment and energy. Second, there has been increased emphasis on the affective domain. Eight affective descriptive components and one experiential component were included in the assessment Third, more emphasis has been placed on the application of principles and on analytic skills, while the lower level cognitive skills have been de-emphasized somewhat. Fourth, the objectives and items were designed so that in addition to the usual item-by-item reporting, meaningful summarizations over various science areas can be made

Cognitive

Table 1 contains a percentage breakdown of the number of items in the nine major cognitive categories included in the assessment of 9-year-olds, 13-year-olds and 17-year-olds. Some items were classified into more than one major category (e.g., an item may fit into both biology and science and self) and the percentages in Table 1 reflect these multiple classifications. Specific objectives that would lead to the development of items were written for each of the nine content categories.

The biology and physical science categories include topics which have traditionally been part of the biological and physical science curriculum. The earth sciences category includes astronomy, geology, meterology and oceanography. The integrated topics category includes items measuring understanding of unifying concepts such as change, time-space and systems. The process-methods category includes topics such as assumptions, classification, interpretation of data and measurement. The decision-making category measures the ability to apply formal decision-making skills,

Table 1

Cognitive Categories in the 1976-1977 Science Assessment -- Percentage Breakdowns within Age Group

	Age 9	13	17
Content			
Biology	26.7	21.8	18.3
Physical Sciences	30.7	20.8	21.7
Earth Sciences	12.3	11.8	9.9
Integrated Topics	0.8	3.9	4.8
Processes			
Process-Methods	17.5	16.0	15.7
Decision Making	0.4	2.9	4.3
Science and Society			
Persistent Societal Problems	5.2	12.9	13.7
Science and Self	6.0	6.0	6.3
Applied Science and Technology	0.4	3.9	5.3
	100.0	100.0	100.0

NOTE: Some items were classified into more than one category.

such as the definition of problems and identification of goals, constraints and other information needed to reach a decision. The persistent societal problems category includes knowledge and understanding of problems such as environment, population, and growth and resource management. The science and self category includes topics in health and safety most likely taught in science classrooms. The science and technology category includes items measuring knowledge of the contributions technology has made to our quality of life, and of future promise and danger of various technological endeavors.

Experiential

An experiential component was included in the assessment to gather descriptive information on students' concrete experiences with the natural world and hands-on experiences investigating the natural world.

Affective

The eight affective components were designed to be descriptive -- to find out what attitudes and values are held, and ultimately, the direction of attitude change over time. The eight groupings include:

1) attitudes toward science classes;
2) vocational and educational intentions regarding science and technology;
3) personal involvement in science-technology related societal problems;
4) personal use of the tools and attributes of science and technology;
5) confidence in science;
6) support of research;
7) opinions on controversial issues involving science and technology;
8) awareness of the methods, assumptions and values of science.

Support of Research: Focus of the Present Study

This paper presents data on affective component number six -- support of research. Perhaps the audience most concerned with young Americans' understanding of science and attitudes towards science is the scientific community itself. More decisions regarding specific research and technological developments are being made today in the public arena, and attitudes held by today's youth may influence the direction research takes in coming decades.

The remainder of this paper

1) briefly summarizes recent concern in the scientific community over public attitudes towards science,

2) reviews public opinion data on attitudes towards science, and

3) presents some findings from the 1976-1977 science assessment on support for scientific research among the nation's youth.

Scientific Community Concern About Public Confidence in Science

The American scientific research community has become deeply concerned in recent years about a loss of public confidence in science and technology. The euphoria of science in the post-Sputnik sixties has been replaced by many challenges to the very structure of science in the seventies. The National Science Board in 1976 conducted an extensive survey of over six hundred representatives of the research community in universities, industry, government and independent research institutes throughout the United States. The scientists were asked to provide their views on conditions affecting research or likely to affect it in the near future. The Board published its findings in a report entitled Science at the Bicentennial -- A Report from the Research Community. In nearly all of the problems that the respondents reported (e.g., funding, freedom, vitality of the research enterprise), changes in the public attitude toward science and technology were thought to be partly responsible. A view typical of many respondents was expressed by A. S. Gregory, Director of Central Research and Development at Weyerhauser Company:

> The number one problem is society's attitude regarding the importance of scientific and technological advances . . . . Recently, it has become a popular game of the uninformed to state that we have all the science and technology we need and that many of our current problems stem from past technological advances. A significant sector of society does not seem to realize that many of the things that give us our preferred quality of life are possible because of technology. It is true that we need to refocus our goals for technology, but I see a need for more technology and not less if we are to meet our challenges of the future.

The December 9, 1977 issue of Science devoted its lead editorial to the crisis of confidence in science. The editorial concluded that ambivalence, not rejection, best describes public attitudes. It suggested that

the scientific community heighten public interest in science by relating science increasingly to problems of health, environment, energy and society.

Survey Data on Public Attitudes[2]

Public opinion polls have not depicted an altogether gloomy picture of public attitudes towards science. Periodic surveys taken since 1966 by either Louis Harris or the National Opinion Research Center suggest that scientists have shared in a general drop in the public's esteem for public institutions since the middle sixties; but in comparison with other professionals, they have held their own or even gained. The high standing in the public mind of scientists compared to other professions was also confirmed elsewhere, including the California poll taken in that state in 1975 and survey results reported in Science Indicators--1972 and Science Indicators--1974.

Several polls asked respondents to indicate areas in which they would like to see their taxes spent for science and technology. Surveys conducted by Opinion Research Corporation indicate that the public (eighteen years and older) would "most like" to see their tax money for science and technology spent for health care, reducing crime, reducing and controlling pollutants, preventing and treating drug addiction, and improving education. Among the least highly ranked areas were space exploration

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[2]All public opinion poll results reported in this section may be found described in greater detail in Science Indicators--1972, Science Indicators--1974, or Science at the Bicentennial. All three are publications by the National Science Board of the National Science Foundation.

and developing and improving weapons for national defense. Results of the Purdue Opinion Poll of 1975 show clear differences between public support of basic and applied science research. Sixty-nine percent of the respondents (high school students) agreed that "money should not be given for scientific research unless it has practical value."

Demographic group breakdowns were reported in the results of several surveys. Findings published in Science Indicators--1974 suggest that men have more favorable attitudes towards science and technology than women. The more highly educated and those with higher incomes were more favorable. A survey in 1968 by Yankelovich of the nation's youth found that those with low incomes or with low occupational prestige ratings had relatively low confidence in scientific leaders. Consistent findings were reported in 1972 by Irene Taviss based on results from a small sample in the Boston area. Individuals who were more educated or better informed on technological issues were more likely to be "pro-technology."

Contributions of the Present Study

The 1976-1977 National Assessment of Science can make an additional significant contribution to previous public survey findings by relating science performance to support for research. The present paper, therefore, is intended to contribute to previous findings by exploring a data base obtained from a national sample of 17-year-olds for relationships among 1) support for basic and applied scientific research attitude items, 2) knowledge of related science topics, 3) demographic data, and 4) self-report questionnaire data. A second intention is to demonstrate that National Assessment data can be useful to educational researchers engaged in exploratory or hypothesis-generating work.

Data Source

The data used in this exploration were collected in March to May 1977 from a national sample of 3,048 17-year-olds who were part of the 1976-1977 science assessment. This sample of examinees was given the same booklet of questions administered in a forty-five minute testing session.[3] The materials in the test booklet were developed to gather both attitudinal and cognitive information on specific topics of national concern. The attitude items assessed the examinees' support of both basic and applied scientific research. Thirty-five cognitive items (eleven multi-part) were included. Several items measured basic facts and principles of science; most items measured science knowledge in the same, or related, topics covered by the research support attitudinal items. In addition, each student completed a short background questionnaire on matters such as parental education, home environment, television viewing, homework habits and number of siblings.

Support for Research -- Total Sample Results

National results on the fourteen items which measure support for basic science research (BRS) are contained in Table 2. The nineteen items used to measure support for applied research (ARS) are similarly displayed in Table 3. The items within a table are ranked according to the percentage responding to the "Definitely Yes" category.

The data reported in these and all succeeding tables are weighted. National Assessment uses a three-stage, deeply stratified sample design with disproportionate sampling of certain subpopulations to assure adequate

[3] This booklet was one of eleven booklets developed for 17-year-olds. A total of 34,512 17-year-olds (an average of 3,137 per booklet) took part in the 1976-1977 science assessment.

Table 2

Responses of Total Sample to "Support for Basic Science Research" Items

Description of Item: Do you think scientists should be given money to study . . .	Percentage of Response: Definitely Yes	Probably Yes	Probably No	Definitely No	No Response
1. efficient, lightweight ways of storing chemical energy?	74.5	22.4	2.4	0.6	0.1
2. how X-rays change living cells?	62.5	31.7	4.7	1.1	0.0
3. chemicals in sea water?	48.7	41.6	7.7	1.9	0.1
4. small parts of the atom?	31.2	48.4	17.1	3.3	0.0
5. how genes control plant characteristics?	30.3	46.0	20.3	3.3	0.1
6. storms on the surface of the sun?	27.8	43.3	21.6	7.2	0.1
7. how bacteria and green plants live together?	26.4	48.0	21.5	4.1	0.0
8. distant stars?	26.3	47.1	22.1	4.4	0.1
9. how animals communicate?	21.8	46.0	25.8	6.3	0.1
10. how the continents move around?	21.7	45.3	22.7	10.1	0.2
11. how mice react to drugs at different times of the day?	20.8	35.6	27.6	15.9	0.1
12. habits of fish in the ocean?	20.5	45.4	27.8	6.3	0.0
13. how gases condense around crystals?	15.2	51.3	29.0	4.4	0.1
14. how monkeys learn?	14.0	42.0	33.4	10.6	0.0
Average Response	31.55	42.44	20.26	5.68	0.07
Median Response	26.35	45.35	21.85	4.40	0.075

Table 3

Responses of Total Sample to "Support for Applied Science Research" Items

Description of Item: Do you think scientists should be given money to study . . .	Percentage of Response: Definitely Yes	Probably Yes	Probably No	Definitely No	No Response
1. cures for cancer?	95.4	3.9	0.4	0.3	0.0
2. methods of reducing air pollution?	88.1	10.2	1.1	0.6	0.0
3. ways to solve the energy problem?	86.1	12.1	1.5	0.3	0.0
4. ways to produce more food?	81.5	14.9	2.7	0.9	0.0
5. ways to use solar energy?	77.4	20.1	2.0	0.5	0.0
6. earthquake prediction?	77.2	19.5	2.3	1.0	0.0
7. how to develop low pollution, electric, transportation systems?	60.7	32.8	5.4	1.1	0.0
8. how to make rain fall on farm land?	54.7	26.7	11.0	7.6	0.0
9. ways to cure a very rare disease?	53.1	32.7	12.0	2.1	0.1
10. fire safety problems?	50.1	38.1	9.6	2.2	0.0
11. ways to solve population problems?	49.8	31.2	14.5	4.5	0.0
12. how to prevent droughts?	47.6	35.7	13.1	3.1	0.5
13. methods of birth control?	43.2	37.7	11.9	7.0	0.2
14. transportation problems?	40.8	43.2	12.4	3.6	0.0
15. methods of farming the oceans?	40.7	37.2	15.9	6.2	0.0
16. ways to maintain a steady and plentiful supply of fish for food?	38.6	43.7	14.8	2.6	0.1
17. ways to control insects?	36.4	44.8	14.1	4.6	0.1
18. how people behave when they live in very crowded cities?	11.4	34.9	38.4	15.3	0.0
19. new ways to build smoke stacks?	7.0	19.2	35.0	38.7	0.1
Average Response	54.73	28.35	11.48	5.39	0.06
Median Response	50.1	32.7	11.9	2.8	0.0

representation. All responses from the sample were assigned weights in inverse proportion to their probability of selection, and the weighted responses were used for all population (and subpopulation) estimates. Weighted-response procedures are available in many computer statistical packages. (SPSS was used for all analyses in this study.)

The results in Tables 2 and 3 suggest that 17-year-olds generally support both basic and applied research; they are also discriminating in the degree of support for various research topics. If support is defined as either a "Definitely Yes" or "Probably Yes" response, then on the average approximately seventy-four percent support basic research and eighty-three percent support applied research. No item in Table 2 and only two items (numbers eighteen and nineteen) in Table 3 command the support of less than a majority of respondents. (It may be that in item 19, Table 3, the respondents did not realize that new smoke stacks would be more effective in reducing air pollution.)

In line with the Purdue Opinion Poll findings, the support for basic research topics was somewhat less positive than was support for more obviously practical (applied) research topics. The 17-year-olds overwhelmingly gave "Definitely Yes" support to applied research for cancer cures (95.4 percent), reducing air pollution (88.1 percent), solving the energy problem (86.1 percent), and producing more food (81.5 percent). Support diminished somewhat for items describing specific applied research projects which would help solve the four problems listed above (compare items 2 and 7; items 3 and 5; items 4 and 15). (It should be noted that what is being called "basic research" in Table 2 is <u>not</u> as "basic" as the typical basic research that goes on in the nation's university and industrial

laboratories. It is perhaps "basic" from the viewpoint of the average 17-year-old, or at least less applied than the research items in Table 3.)

Demographic Breakdowns

In order to gain further insight into results on the support for research items, two mean support scores were computed -- one for the fourteen basic research items and another for the nineteen applied research items. The following response scaling was applied: 4 = "Definitely Yes"; 3 = "Probably Yes"; 2 = "Probably No"; 1 = "Definitely No." Additionally, mean percentage correct scores were computed for the thirty-five item cognitive measure of related topics.

The means and standard deviations[4] of these three measures are displayed in Table 4 for the national sample of 17-year-olds and for four demographic classifications.

The statistics for a measure were computed only on those examinees who answered all items of the measure. Approximately 0.7 percent of the respondents failed to complete all fourteen basic research support (BRS) items, 1.5 percent did not complete all nineteen applied research support (ARS) items and 2.5 percent did not answer all thirty-five cognitive (Cog) items. Thus, the statistics for the three measures were computed on three slightly different samples. Instead of displaying the percent of respondents in each demographic subgroup for <u>each</u> of the three measures (the percents would be nearly identical), an average percent for each subgroup was computed over all three measures and these averages are displayed in the table under the heading "Percent of Respondents in Subgroup."

[4]Standard deviations are only approximate since stratification and clustering cannot be taken into account by SPSS computer programs.

Table 4

Group Performance on Basic Research Support (BRS), Applied Research Support (ARS) and Cognitive (Cog) Measures

Group	Percent of Respondents in Subgroup	Mean BRS	Mean ARS	Mean Cog	Standard Deviation BRS	Standard Deviation ARS	Standard Deviation Cog
National		3.00	3.325	53.1	0.45	0.37	16.6
Sex							
Males	50.35	3.00	3.34	54.9	0.46	0.38	17.1
Females	49.65	3.01	3.31	51.4	0.43	0.37	15.9
Race							
White	83.65	3.01	3.34	55.4	0.44	0.37	16.0
Black	12.57	2.96	3.21	40.0	0.45	0.39	13.6
Other	3.78	3.00	3.26	46.4	0.45	0.38	17.1
Region of Country							
Northeast	24.31	3.02	3.36	55.4	0.43	0.36	16.8
Southeast	19.68	2.98	3.29	49.3	0.45	0.38	15.9
Central	34.88	2.98	3.33	54.3	0.45	0.37	16.8
West	21.13	3.03	3.31	52.2	0.47	0.39	16.1
Size of Community							
Big City	20.17	3.01	3.28	48.2	0.47	0.40	16.6
Fringes of Big City	20.53	2.95	3.34	55.4	0.46	0.37	16.2
Medium City	12.26	3.09	3.39	56.7	0.43	0.38	15.9
Smaller Places	47.04	2.99	3.32	53.4	0.43	0.36	16.5

NOTE: The fourteen BRS and nineteen ARS items are scored on a four-point scale (4 = "Definitely Yes"; 3 = "Probably Yes"; 2 = "Probably No"; 1 = "Definitely No"). The 35-item cognitive measure is reported as mean percentage correct.

The average nationwide support for basic research by 17-year-olds was 3.00 which, translated to the four-point scale, is a "Probably Yes" response. The corresponding support for applied research was 3.325, about one-third of the way between an average "Probably Yes" and a "Definitely Yes" response. The mean performance nationwide on the cognitive measure was 53.1 percent correct. All three measures had rather large standard deviations, a further indication that for the two attitudinal measures, respondents did not merely respond "Yes" to all items.

The nationwide poll of adults published in Science Indicators--1974 found, on the basis of two items, that men were somewhat more positive than women to science and technology. In the present study, 17-year-old males and females did not differ on the average in their support of research. The males did hold a small performance edge on the cognitive measure (54.9 percent to 51.4 percent).

Whites tended to be more supportive of research than blacks. The differences were small for basic research (3.01 versus 2.96) but increased for applied research (3.34 versus 3.21). Large racial differences in applied research support were noted for six items in Table 3. Whites were more supportive than blacks for items 8, 12 and 15 (rainfall/food production) and for item 11 (solve population problem). Blacks were more supportive than whites for item 9 (cure a very rare disease) and for item 10 (fire safety). Blacks trailed whites by 15.4 percentage points on the cognitive measure.

Regional differences in support of research were small and depended somewhat on the type of research. (See Appendix A for a regional map of the states.) The Southeast trailed the other regions slightly on the cognitive measure.

The "Medium City" subgroup was more supportive than other community types for both basic and applied research. (See Appendix A for definitions of "Size of Community.") This same subgroup also scored highest on the cognitive measure.

Two-way Breakdowns within Racial Group

Mean performance levels for the same three measures (BRS, ARS and Cog) are shown in Table 5 within each of two racial groups (white and

Table 5

Breakdowns within Racial Group of Mean Performance on
Basic Research Support (BRS), Applied Research Support (ARS) and Cognitive (Cog) Measures

Reporting Category	Percent of Race in Subcategory	Mean Performance BRS	ARS	Cog
Sex				
White				
Males	49.87	3.00	3.35	57.2
Females	50.13	3.01	3.34	53.7
Black				
Males	50.77	2.96	3.24	41.6
Females	49.23	2.96	3.17	38.4
High School Curriculum				
White				
General	45.92	2.92	3.28	50.5
Academic	38.56	3.12	3.44	63.0
Vocational	15.52	2.96	3.32	52.4
Black				
General	42.48	2.93	3 17	38.4
Academic	36.84	3.04	3.30	44.7
Vocational	20.68	2.88	3.15	36.3
Highest Education of Either Parent				
White				
Less than twelfth grade	12.24	2.93	3.28	49.0
Twelfth grade	37.08	2.95	3.31	53.0
Post high school	47.72	3.08	3.40	59.6
Parental education unknown	2.96	2.82	3.14	48.1
Black				
Less than twelfth	27.05	2.98	3.19	38.5
Twelfth grade	31.74	2.94	3.17	39.2
Post high school	31.40	2.94	3.25	44.5
Parental education unknown	9.81	3.02	3.19	33.9
Expectation of College Graduation				
White				
"Yes"	50.09	3.13	3.42	61.4
"No"	26.64	2.87	3.28	48.1
"I don't know."	23.27	2.95	3.26	51.9
Black				
"Yes"	63.96	3.01	3.27	42.9
"No"	13.14	2.83	3.06	34.9
"I don't know."	22.90	2.88	3.21	35.1
Time on Homework Yesterday				
White				
None assigned	35.91	2.93	3.31	51.5
Didn't do it	13.28	2.94	3.27	54.3
Less than one hour	21.93	3.04	3.36	56.3
One to two hours	21.26	3.13	3.41	59.2
More than two hours	7.62	3.14	3.43	64.6
Black				
None assigned	43.86	2.92	3.14	37.2
Didn't do it	8.70	2.88	3.39	42.8
Less than one hour	18.77	2.95	3.24	41.3
One to two hours	19.85	3.04	3.22	40.7
More than two hours	8.82	3.06	3.32	49.4
Time Viewing TV Yesterday				
White				
None	19.96	3.03	3.34	56.4
One hour or less	30.20	3.03	3.37	57.6
Two to three hours	33.41	2.99	3.34	55.1
Four or more hours	16.43	2.97	3.31	52.0
Black				
None	16.49	2.97	3.25	39.8
One hour or less	21.82	3.00	3.24	42.2
Two to three hours	29.38	2.94	3.23	39.2
Four or more hours	32.31	2.93	3.17	39.9

NOTE: The fourteen BRS and 19 ARS items are scored on a four-point scale (4 = "Definitely Yes"; 3 = "Probably Yes"; 2 = "Probably No"; 1 = "Definitely No"). The thirty-five item cognitive measure is reported as mean percentage correct.

black) for categories of the following six variables: 1) sex, 2) high school curriculum, 3) highest education of either parent, 4) expectation of college graduation, 5) time spent on homework yesterday, and 6) time spent viewing television yesterday. The percents in Table 5 under the heading "Percent of Race in Subcategory" were computed as in Table 4 by averaging within each subcategory the three slightly different percents of examinees responding to the BRS, ARS and Cog measures.

The results on the six variables are briefly summarized as follows:

1. Sex. White males and white females did not differ in their support of research. Black males and black females agreed in their support of basic research, but the black males were somewhat more supportive than black females (3.24 to 3.17) of applied research. Black males and white males outperformed their female counterparts on the cognitive measure by over three percentage points.

2. High School Curriculum. Both blacks and whites enrolled in academic programs were more supportive of research and scored higher on the cognitive measure than their counterparts enrolled in general or vocational programs.

3. Highest Education of Either Parent. There was a relationship for both blacks and whites between cognitive performance and the highest educational attainment of either parent -- examinees from more highly-educated families scored higher. The association of higher parental education with higher scores on both research support measures held true only for whites.

4. Expectation of College Graduation. Large differences occurred on all three measures between examinee groups who expected to graduate from college and those who did not. Interestingly, more black than white 17-year-olds indicated they expected to graduate from college (sixty-four percent to fifty percent). This contrasts with the parental education results which show that approximately thirty-one percent of the same sample of blacks reported having a parent who completed post-high school

education (in comparison to about forty-eight percent of the whites).[5]

5. Time on Homework Yesterday. Whites who reported spending more time on homework scored higher on all three measures than did other whites who reported doing little or no homework. These relationships were not so apparent for blacks. (Sample sizes in some of the black subcategories are rather small. Population mean estimates are therefore subject to greater sampling variability and detecting differences is more difficult.)

6. Time Viewing Television Yesterday. Perhaps the most revealing statistic here is that approximately twice as many blacks as whites (thirty-two percent to sixteen percent) reported viewing four or more hours of television the previous day. This same subgroup of blacks scored at the national level for all blacks on the cognitive measure, but were somewhat less supportive than other blacks of both types of research. Whites who reported being heavy television viewers (four hours or more) scored below the national levels for whites on all three measures.

4 x 4 Contingency Tables

The correlations in the nationwide sample of 17-year-olds between mean cognitive performance (Cog) and mean scores on basic research support (BRS) and applied research support (ARS) are .311 and .378 respectively.

These two relationships were examined more closely by first dividing the three score distributions into four quarters and then constructing two 4 x 4 tables of quartile groups. The resulting tables are displayed in Table 6-A (BRS x Cog) and Table 6-B (ARS x Cog).

[5] Current Population Reports, Series P-20, No. 319, issued in February 1978 by the Bureau of the Census shows recent dramatic increases in college enrollment of blacks. In 1976 college enrollment of black students 14 to 34 years old reached 1.1 million, about twice the number enrolled in 1970. Approximately 15.5 percent of all blacks 18 to 34 years old were enrolled in college in October 1976. This compares with a 16.6 percent enrollment of all whites in the same age group.

Tables 6-A and 6-B

Percents in Each Quartile Group of Mean Performance on the Cognitive Measure for Each Quartile Group of Mean Performance on
A) Basic Research Support (BRS) and
B) Applied Research Support (ARS) Measures

	BRS Quartile Groups	Cognitive Quartile Groups				
		First	Second	Third	Fourth	(Row Total)
(A)	First	36.1	28.9	19.3	15.7	(100.0)
	Second	30.3	26.4	22.4	20.9	(100.0)
	Third	23.6	22.1	23.9	30.4	(100.0)
	Fourth	13.1	19.4	26.2	41.3	(100.0)

	ARS Quartile Groups	Cognitive Quartile Groups				
		First	Second	Third	Fourth	(Row Total)
(B)	First	42.2	27.8	17.9	12.1	(100.0)
	Second	27.5	25.2	23.4	23.9	(100.0)
	Third	20.9	25.0	26.4	27.7	(100.0)
	Fourth	11.3	18.4	24.6	45.7	(100.0)

The four numbers in a table row represent the percents in the cognitive quartile groups for the research support quartile defined by the row. For example, the first row data in Table 6-A are read as follows: of those respondents who were in the quartile group least supportive of basic research (first quartile), 1) 36.1 percent were also in the lowest scoring group (first quartile) on the cognitive measure, 2) 28.9 percent were in the second quartile, 3) 19.3 percent were in the third quartile and 4) only 15.7 percent fell into the highest scoring group (fourth quartile) on the cognitive measure.

The data in the two tables suggest that the positive correlations between the cognitive and research support measures resulted largely from differences on the cognitive measure by members in the lowest and highest

research support groups (rows one and four). These differences between rows one and four are slightly larger overall in Table 6-B ($r = .378$) than in Table 6-A ($r = .311$). Examinees in the second research support quartiles tended to score somewhat lower on the cognitive measure then those in the third quartiles, but these differences were not large.

Hypothetical Causal Relationships

Any attempt to draw causal inferences from non-experimental data is subject to the criticism that the variables under consideration may be influenced by factors that can neither be manipulated nor ruled out on the basis of randomization. However, it has been argued that there are currently few well-established causal relationships in the social sciences, and to ignore existing observational (non-randomized) data may be counter-productive (Rubin, 1974).

National Assessment data are not gathered under controlled experimental conditions; yet, as Burton (1978) points out, the data do have desired characteristics such as breadth, precision and accuracy. The data are particularly useful for providing hypotheses about causes.

> In exploring assessment data, the analyst in essence is trying different organizations or structures for the results. The analyst can eliminate many implausible hypotheses by exploring the data. Thus, assessment can be seen as a proving ground in which many ideas can be proposed and eliminated and the few strong ideas can be located for further, more controlled, exploration (Burton, 1978, p. 24).

Path analysis is a method of analysis designed to shed light on hypotheses about causes. These causes cannot be discovered in path analysis. Rather, path analysis can help determine if the data are consistent with the causal model hypothesized by the researcher. Consistency

of the data with the explanatory model, however, is not proof of a theory; it only lends support to it (Kerlinger, 1973, p. 307).

Six variables were selected from the data base used in the present study to illustrate the use of path analysis in exploring hypotheses about causes. The two alternative causal models postulated in this section are not meant to be precise representations of reality. However, in exploratory research where no paradigm prevails, simple models with a minimum of assumptions are good starting places, for they can furnish useful insights about the data and lead ultimately to more general concepts.

The intercorrelation matrix and a description of the six selected variables are contained in Table 7.[6] The applied research support (ARS) and cognitive (Cog) variables are the same two measures used in earlier analyses in this paper. Home environment was part of the questionnaire data. Parental education is displayed, with categories one through three combined, in Table 5.

[6]Intercorrelations were computed only on blacks and whites (ninety-six percent of the total sample). Further, casewise deletion for missing values was used. About twelve percent of the black/white sample was lost as a result.

Table 7

Intercorrelation Matrix of Selected Variables on Nationwide Sample of Blacks and Whites[1]

	(1)	(2)	(3)	(4)	(5)	(6)
1) Race	1.000					
2) Sex	- .032	1.000				
3) Home Environment	.107	.042	1.000			
4) Parental Education	.163	- .017	.275	1.000		
5) Applied Research Support (ARS)	.121	.056	.139	.141	1.000	
6) Cognitive (Cog)	.296	.113	.216	.260	.362	1.000

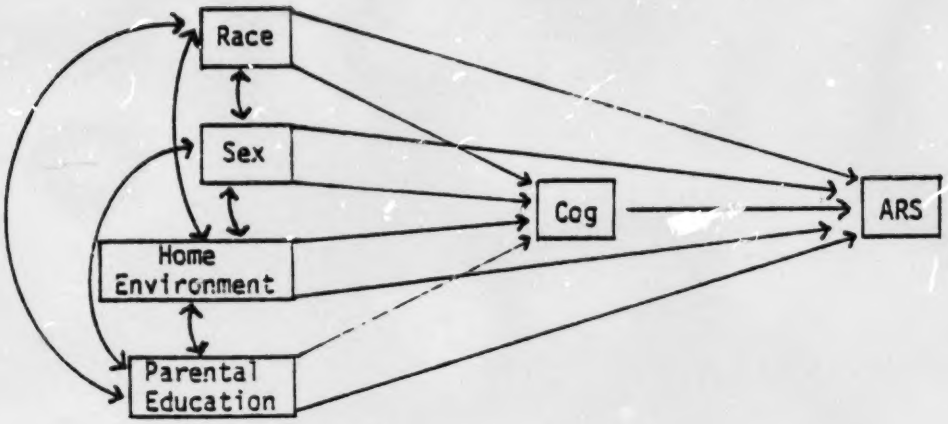
[1]Casewise deletion for missing values reduced the black/white sample by 12.2 percent

Description of Variable Codes

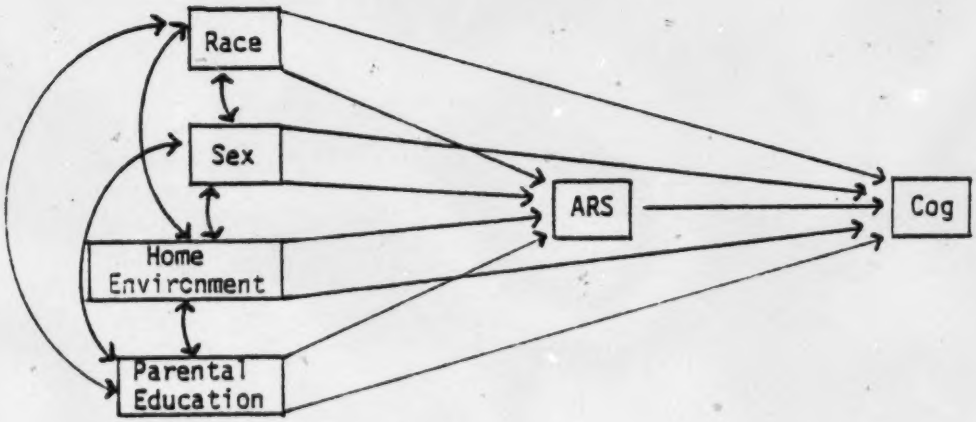
1) Race -- 1 = Black, 2 = White
2) Sex -- 1 = Female, 2 = Male
3) Home Environment -- A five-item measure scored from 0 to 5. Score is number of "Yes" responses to items dealing with presence/absence of elements in the home environment thought to foster learning.
4) Parental Education -- Highest education of either parent: 1 = less than eighth grade; 2 = eighth grade; 3 = high school, but did not graduate; 4 = graduated from high school; 5 = some post-high school education.
5) Applied Research Support -- ARS: mean score on the nineteen-item measure described in Table 3. Items are scored on same four-point scale noted in Table 4.
6) Cognitive -- Cog: mean percent correct on the thirty-five item cognitive measure.

Path diagrams of two unidirectional causal relationships which might be hypothesized among the variables in Table 7 are depicted below.

Model 1



Model 2



In the models, sex, race, home environment and parental education have unspecified causal relationships (as shown by double-arrowed curves), but all four affect the respondent's support of applied science research and the respondent's science achievement. These four variables are considered to be exogenous to the models (i.e., determined by causes outside the models). Model 1 assumes that willingness to support applied science research in certain areas is affected by knowledge of science in the same,

or related, areas; whereas Model 2 assumes the reverse -- science achievement is affected by the respondent's attitudes towards supporting applied research on related science topics. (A more realistic Model 2 might have resulted if an interest in science measure or an achievement values measure had been substituted for the ARS measure. The main analysis concern, however, was to find out how differently the data behave when the causal effects of ARS and Cog are reversed.)

An estimate was obtained from the data in Table 7 of the associated path coefficient (standardized partial regression coefficient) for each path in the two models. (These estimates are ordinary least squares estimates which assume a simple random sample. The effect on least squares regression estimates of using a complex sample design has recently been investigated {Shah et al., 1977}. Preliminary results suggest that when the cluster size is small {ten or less}, reasonably good estimates can be obtained by ordinary least squares. National Assessment surveys have a third-stage cluster size of about sixteen students per school.)

Path analysis results obtained for Model 1 indicate that the four exogenous variables have no direct effect on the support for applied research attitudinal measure (path coefficients are all .05 or less), and the direct pathways of these variables to this measure may therefore be deleted. In the resultant "trimmed" model, indirect effects through the cognitive measure are all rather small (.11 or less). The direct effect of the cognitive measure on attitude is large (.34 in the full model; .36 in the trimmed model), suggesting that <u>within Model 1</u>, a 17-year-old's knowledge of particular science areas does affect to a greater degree support for applied scientific research in the same, or related, areas

than do the direct and indirect effects of sex, race, parents' education, or home environment. This interpretation must be made with caution in light of the restrictive assumptions of path analysis, the missing data and the largely unknown effect of the complex sample design on ordinary least squares estimates of path coefficients.

Bearing in mind the same cautions, path analysis results for Model 2 indicate that all five variables have some direct effect on the cognitive measure (race = .23, sex = .10, home environment = .10, parental education = .15, support for applied research = .29). There are no indirect effects through the attitudinal measure (all are .03 or less). This suggests that the five variables contribute in varying degrees to the prediction of the cognitive measure (multiple R = .50 with the five predictors), but that none of the four exogenous variables acts through the support for applied research attitudinal measure.

Concluding Remarks

This paper has dealt with data collected in the spring of 1977 as part of the 1976-1977 science assessment regarding the willingness of the nation's 17-year-olds to support both basic and applied scientific research. The results suggest that one's knowledge of science may play an important part in determining the extent of that support. It would therefore seem in the best interests of the scientific community to heighten young citizens' interest in and knowledge of science. Of special importance seems to be a need to inform young Americans that scientific knowledge obtained from basic research plays an important role in solving many of society's pressing problems.

The data explored for this study are only a small segment of the total data collected in the third science assessment. The policy of National Assessment is to facilitate secondary analysis by others on data collected. Magnetic tapes containing student-level science assessment data will be made available to the public. Several forthcoming publications will be of interest to researchers. Soon to be published are the science objectives booklet and an exercise set which includes all affective and experiential items in the 1976-1977 assessment plus a portion of the cognitive items. The science technical report will be ready by the end of the year. It will serve as a detailed reference for researchers on such matters as data collection, scoring, analysis and data summaries. Other publications on selected science topics will be issued periodically.

APPENDIX A

DEFINITIONS OF REPORTING GROUPS

The National Assessment of Educational Progress examines results for various groups of people within the national population. These groups are defined as follows.

Group Definitions

Sex

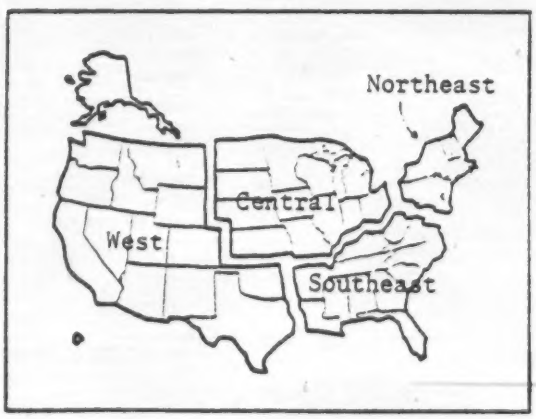
Results are presented for males and females.

Race

Currently, results are presented for blacks and whites.

Region

The country has been divided into four regions — Northeast, Southeast, Central and West. States included in each region are shown on the map following.



Size of Community

Big city. Students in this group attend schools within the city limits of cities with a population over 200,000.

Fringes around big cities. Students in this group attend schools within metropolitan areas served by cities with a population greater than 200,000 but outside the city limits.

Medium city. Students in this group attend schools in cities having a population between 25,000 and 200,000 not classified in the fringes-around-big-cities category.

Smaller places. Students in this group attend schools in communities having a population less than 25,000 not classified in the fringes-around-big-cities category.

Type of Community

These communities are defined by an occupational profile of the area served by a school as well as the size of the community in which the school is located.

Advantaged-urban communities (high metropolitan). Students in this group attend schools in or around cities with a population greater than 200,000 where a high proportion of the residents are in professional or managerial positions.

Disadvantaged-urban communities (low metropolitan). Students in this group attend schools in or around cities with a population greater than 200,000 where a high proportion of the residents are on welfare or are not regularly employed.

Extreme rural. Students in this group attend schools in areas with a population under 10,000 where most of the residents are farmers or farm workers.

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